OPTIMIZATION OF SLUDGE DISINTEGRATION FROM IWK-BUNUS SEWAGE TREATMENT PLANT FOR ENHANCED BIOGAS YIELD

SHEHU MUHAMMAD SANI

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I declare that this dissertation entitled *"Optimization of Sludge disintegration from IWK-Bunus Sewage Treatment Plant for Enhanced Biogas Yield"* is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: .....

Name: Shehu Muhammad Sani

Date: 20th January, 2012

To my beloved Parent, and to the comfort of my eyes: my Wife and Children

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ABSTRACT

Biogas is a source of renewable energy (fuel) produced through anaerobic digestion of biomass. Sewage sludge is a form of biomass that is found as sediment (slurry) product of waste water treatment plants. This research is aimed at optimizing the yield of the biogas produced from Indah Water Konsortium- Bunus sewage treatment plant (STP) through sewage sludge disintegration processes. By optimizing the yield, the STP can generate its own future heat and power demands that can possibly be exported to the grid. To achieve that, the plant was physically studied on its operations. The current population equivalent (PE) of the plant is 175,000 instead of the installed capacity of 375,000. This constitutes towards low total solids (TS) and volatile solids (VS) of about 1.89 and 1.38% respectively, and a low overall biogas yield of 1500 m^3/day (56% VS reduction) instead of recommended 2200 m^3/day (80% VS reduction). Thermal, chemical and thermochemical disintegration techniques were employed to investigate their impact on improving the biogas yield during anaerobic digestion. Modeling and Optimization of the disintegration processes were carried out using STATISTICA. The results of ANOVA and multiple regression analysis show that the optimum variables for the thermal disintegration are: 88°C, 227 rpm and 21 min, with actual degree of disintegration (DD) of 55.4%. For chemical disintegration, the optimum variables are 2.85M NaOH, 229 rpm and 21min and a corresponding optimum DD of 52.68%. The optimum DD for thermochemical disintegration is 61.45% at: 88°C, 2.29M NaOH, and 21 min. Biogas yield was improved by 60%, 15% and 36% v/v using the thermal, chemical and thermochemical disintegration techniques respectively. This shows that yield of biogas can be enhanced through disintegration process, and eventual higher cogeneration potential can be exploited.

ABSTRAK

Biogas ialah sumber boleh diperbaharui (bahan api) yang dihasilkan melalui pencernaan aerobik biojisim. Enap cemar kumbahan ialah satu bentuk biojisim yang boleh ditemui sebagai produk mendapan loji rawatan air sisa. Kajian ini bermatlamat untuk mengoptimumkan penghasilan biogas daripada Indah Water Konsortium-Bunus STP melalui proses penyepaian enap cemar kumbahan. Dengan mengoptimumkan penghasilan, STP boleh menjana permintaan haba dan kuasa sendiri dan berkebarangkalian untuk diekspot grid. Bagi mencapai matlamat, operasi loji telah dikaji secara fisikal. Nilai semasa PE bagi loji ialah 175, 000 berbanding dengan kapasiti 375, 000 semasa pemasangan. Ini terdiri daripada TS dan VS yang rendah sebanyak 1.89% dan 1.38 % masing-masing dan menghasilkan biogas yang sedikit sebanyak 1500 m^3/day (56% VS pengurangan) peratus yang disyorkan iaitu 2200 m^3/day (80% VS pengurangan). Teknik penyepaian haba, kimia dan termokimia telah digunakan untuk menyiasat kesan pencernaan aerobik dalam meningkatkan hasil biogas. Pemodelan dan pengoptimalan untuk proses penyepaian telah dijalankan dengan menggunakan STATISTICA dan keputusan ANOVA dan pelbagai analisis regresi menunjukkan bahawa pemboleh ubah optimum untuk penyepaian haba ialah: 88°C, 227 rpm dan 21min dengan DD sebanyak 55.4%; manakala untuk penyepaian kimia ialah 2.85M NaOH , 229 rpm dan 21 min. DD optimum untuk penyepaian termokimia ialah 61.45% pada: 88°C, 2.29M NaOH, dan 21 min. Hasil biogas telah meningkat sebanyak 60%, 15% dan 36% v/v setelah mengaplikasikan teknik penyepaian haba, kimia dan termokimia. Ini menuhjukkan bahawa hasil biogas boleh ditingkatkan melalui proses penyepaian dan secara tak langsung potensi kogenerasi yang lebih tinggi dapat dicapai.